

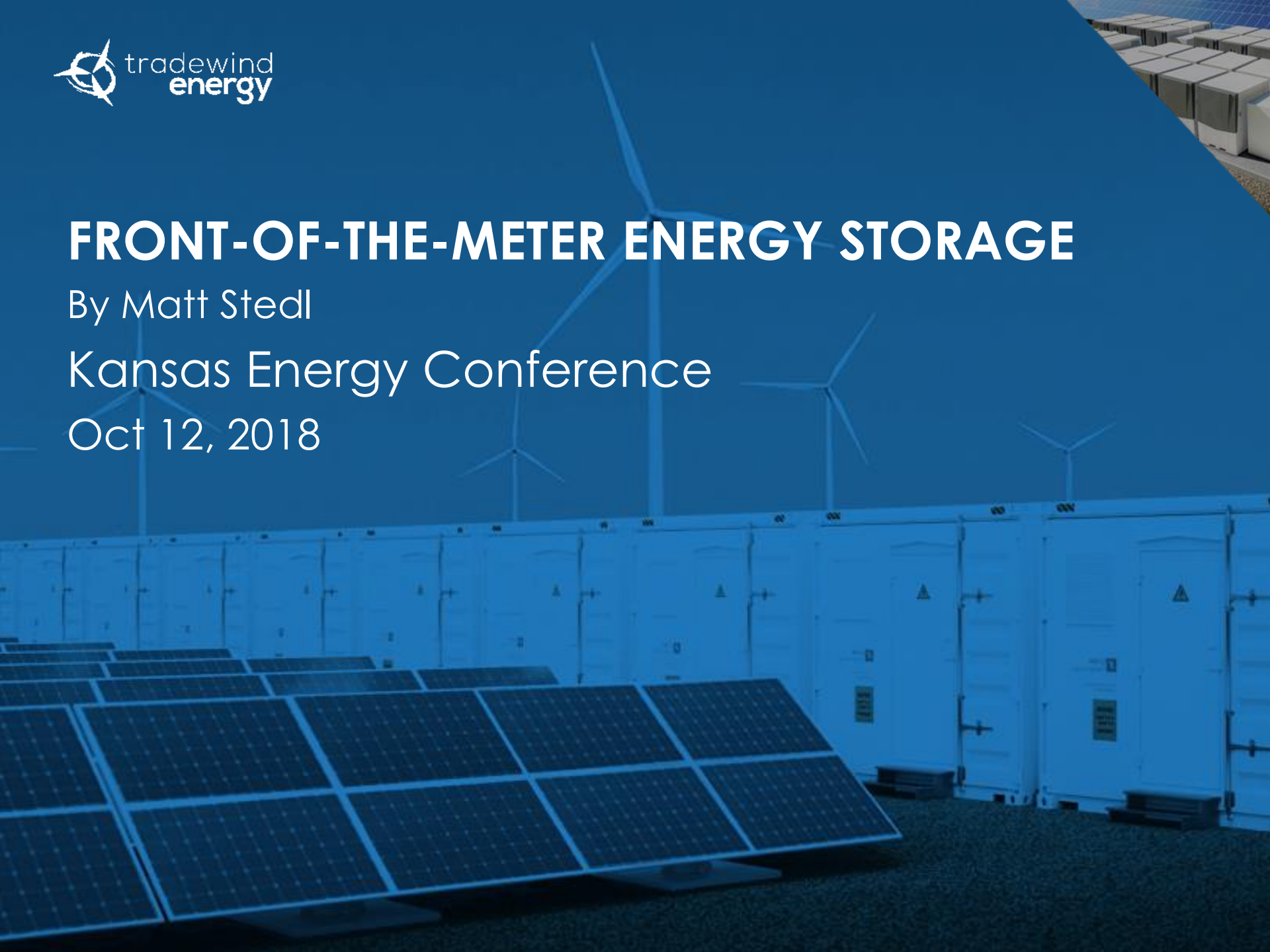


# FRONT-OF-THE-METER ENERGY STORAGE

By Matt Stedl

Kansas Energy Conference

Oct 12, 2018



Among the Largest & Most Successful Wind, Solar, and Storage Development Companies in the U.S.

## • Company Info

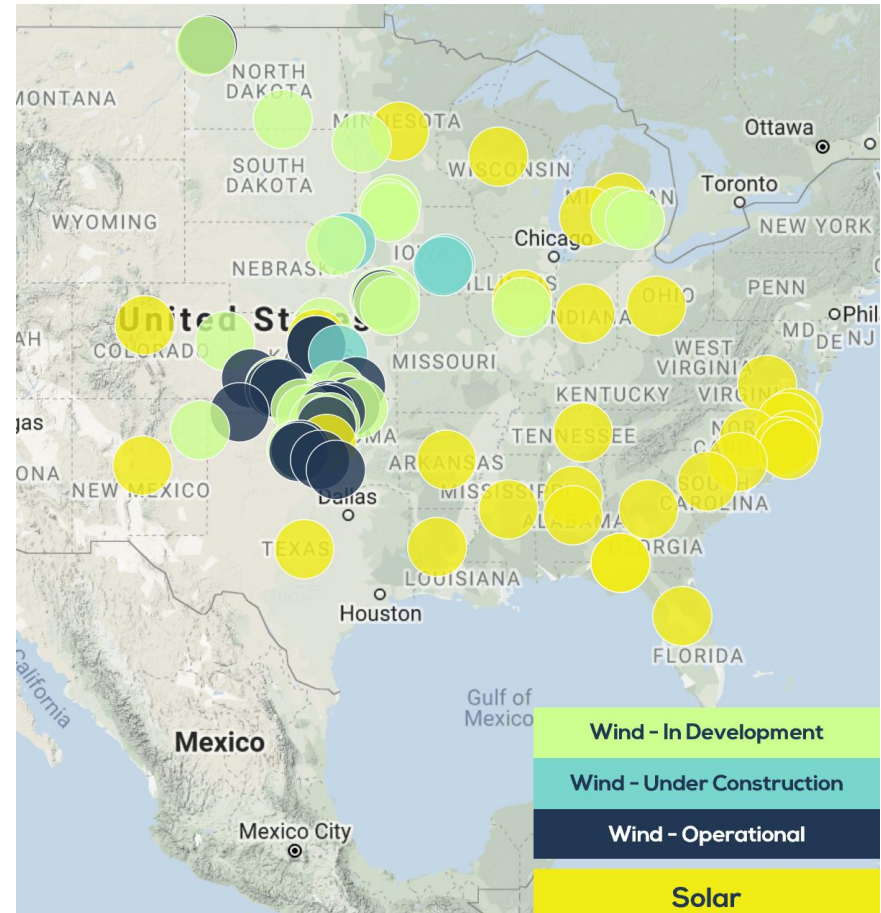
- Founded in 2002
- Headquarters in Lenexa, KS
- 140+ full time employees


## • Current Development Portfolio

- Present in more than 25 states
- #1 US Wind Developer in 2017
- **More than 8 GW of wind assets**
- **More than 3 GW of solar assets**
- **More than 1 GW of storage assets**

## • Tradewind Success

- **3 GW+ contracted & operating projects**
- Successes total more than \$5 Billion capital investments



  
energizing life **Arkansas Electric  
Cooperative Corporation**  
*We Are Arkansas*  
Grand River Dam Authority  
A SOUTHERN COMPANY **Midwest  
Energy, Inc.** **BASIN ELECTRIC  
POWER COOPERATIVE**  
A Touchstone Energy® Cooperative **SUNFLOWER ELECTRIC  
POWER CORPORATION**  
A SOUTHERN COMPANY **KANSAS CITY  
BPU**  
THE POWER OF COMMUNITY **wfec**  
western farmers  
electric cooperative  
A Touchstone Energy® Cooperative  
PACIFIC ELECTRIC COOPERATIVE **PUBLIC SERVICE  
COMPANY OF  
OKLAHOMA™**  
*A unit of American Electric Power*  
A Touchstone Energy® Cooperative **CITY UTILITIES**  
*Bringing Power Home.™* **IPL**  
**Independence**  
Power & Light  
*Your Community Energy Partner*

1. **Front-of-the-Meter (FTM) Energy Storage Applications**
2. **FTM Energy Storage Configurations**
3. **Wind + Storage**
4. **Solar + Storage**
5. **Current FTM Challenges**



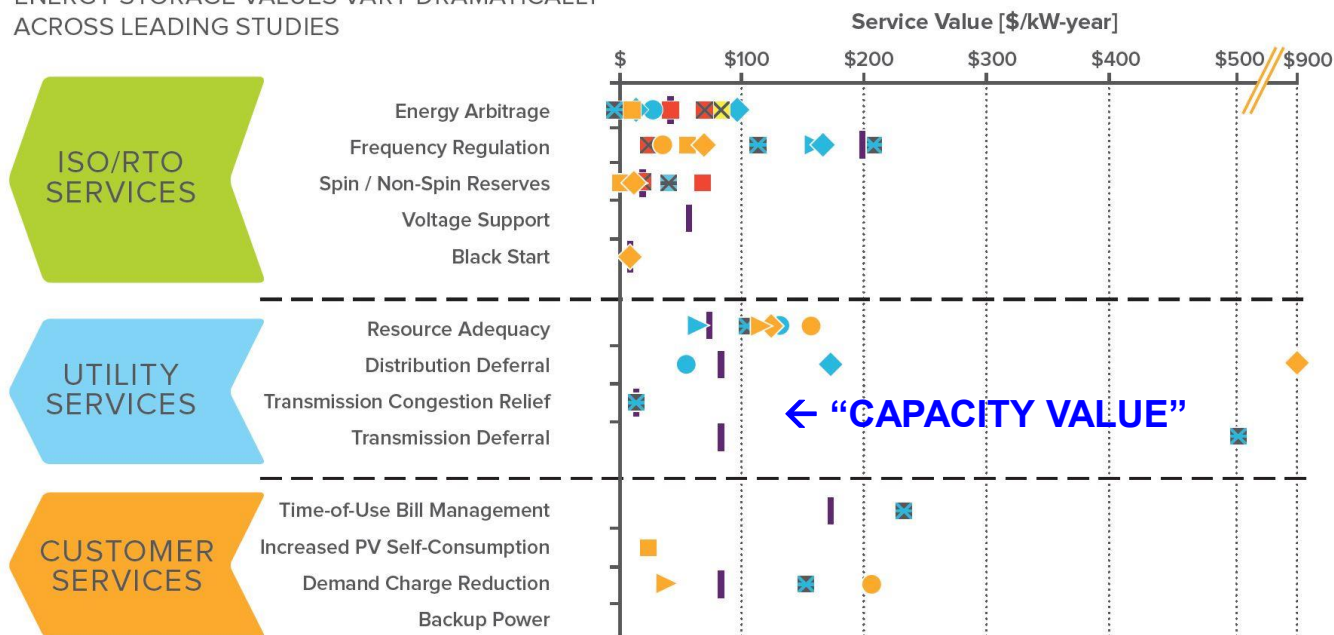
1. Energy Time Shift: Load during times of excess/inexpensive generation, Generator at peak load times
2. Provide Firm Capacity to non-firm solar and wind projects
3. Act as a shock absorber to the system
  - Frequency Regulation (fast response)
4. Transmission and Distribution deferral
5. Provide Backup Power





**FIGURE ES1**

ENERGY STORAGE VALUES VARY DRAMATICALLY  
ACROSS LEADING STUDIES



Results for both energy arbitrage and load following are shown as energy arbitrage. In the one study that considered both, from Sandia National Laboratory, both results are shown and labeled separately. Backup power was not valued in any of the reports.

● RMI UC I    ◆ RMI UC II    ► RMI UC III    ■ RMI UC IV    ■ NYSDA    ■ NREL    ● Oncore-Brattle    ■ Kirby  
 ► EPRI Bulk    ■ EPRI Short Duration    ◆ EPRI Substation    ■ Sandia    ■ Sandia: LF



THE ECONOMICS OF BATTERY ENERGY STORAGE



## IN DECREASING ORDER OF MARKET VALUE\*

1. **Frequency Regulation**
2. **Capacity Value (or “Resource Adequacy”)**
3. **Transmission Deferral**
4. **Distribution Deferral**
5. **Spinning Reserve**
6. **Energy Arbitrage (buy low, sell high)**
7. **Voltage Support / Blackstart**

\*Market Values are highly location-dependent, this is a representative list of market values based on the higher end of projected values



- **Stand-Alone Storage** - Wholesale “Generator” & “Load”:
- **Stand-Alone Storage** - Transmission and/or Distribution Asset
- **Stand-Alone Storage** - Transmission / Distribution Asset AND Wholesale Generator/Load??
- **Wind + Storage** - Co-located with Wind
- **Solar + Storage** - Co-located w/Solar
- **Other** (Gas + Storage, Compressed Air, Pumped Hydro, ...)





- **Wind + Storage Attributes**

- Energy Arbitrage (on-wind vs off-wind)
- Curtailment abatement (charge from wind during curtailment/negative pricing events)
- Firm Capacity Value
- Bulk Storage options (long duration)
- Ramp Rate Control (no rapid cut-out)
- FR/Ancillary services
- NOT ITC eligibility (typically)

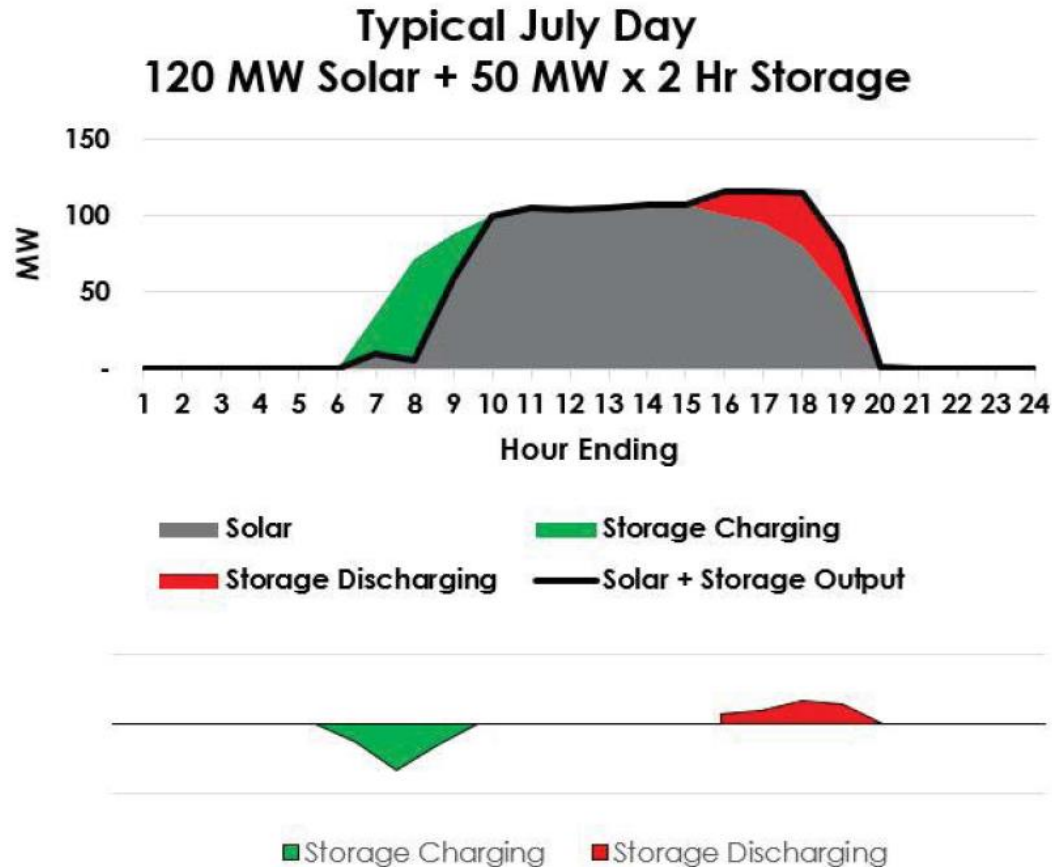


## Benefits of Solar and Storage

- Firm capacity and energy from a renewable resource when coupled with solar
- Storage qualifies for the ITC when charged from solar (first five years)
- Option to charge from the grid post-ITC period
- Other revenue possibilities
  - Energy arbitrage
  - Spinning reserves
  - Frequency regulation
  - Voltage support
- Added system flexibility/black start and ramp rate control capability
- Pricing structure options
  - Fixed & variable
  - Blended \$/MWh (solar+storage)
- FERC Order 845
  - Will allow net zero addition of storage capacity without material modification to Interconnection – subject to the current ISO rule-making process



# Solar + Storage Dispatch Profile



# Current FTM Energy Storage Challenges:

1. **Market Participation** (FERC Order 841 to address)
2. **Interconnection Process** (FERC Order 845 to address)
3. **Proper compensation** for value provided to system (FERC Order 841 to address)
4. **Lack of predictable cash flow** (State mandates/procurements helping a lot)





**Matt Stedl**

Development Director, Energy Storage

Tradewind Energy, Inc.

312-617-1335

mstedl@tradewindenergy.com

[www.tradewindenergy.com](http://www.tradewindenergy.com)

